FOREST SERVICE
INTERMOUNTAIN
RECEIVED
DEC 5 1956
FOREST INSECT LAB.
MISSOULA, MONT.

FOREST ENTOMOLOGY IN SOUTHERN UNITED STATES

By R. J. Kowal

Not For Publication

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Southeastern Forest Experiment Station

November 1, 1956

Paper presented at 10th International Congress of Entomology, Montreal, Canada - To be published in Proceedings of Congress

FOREST ENTOMOLOGY IN SOUTHERN UNITED STATES

By R. J. Kowal, Southeastern Forest Experiment Station
Forest Service, U. S. Department of Agriculture

Probably nowhere in the world has greater progress been made in forestry during recent years than in the southern United States. Vigorous activity in all fields of forestry indicate that prospects for the future are very promising. As forest resources and values increase, it is inevitable that forest entomology should assume greater importance in forest protection.

The extreme variation in topography, climate, and forest types which characterizes the South favors the activities of a vast number of insects, many of them very destructive to the forest. Recognition of the importance of the damage they cause has come slowly. For many years forest fires, which presented a major obstacle to forestry in the South, occupied a foremost position in forest protection. Then too, timber values were low. However, as the value of forest products increased, as forest management became more intensive, and a vast complex of forest industries developed, the need for protecting forests from damage by insects was gradually realized.

HISTORY OF FOREST ENTOMOLOGY IN THE SOUTH

Research

It is interesting to note that the science of Forest Entomology in the United States had its real beginning in the South when Dr. Hopkins conducted his early studies on the southern pine beetle in West Virginia about 1890. Since then many well-known forest entomologists have worked there; they include Balch, Beal, Blackman, Craighead, and others. Most of the early work concerned taxonomic studies of our forest insects. Essential information on life histories, habits, and direct control was obtained for the most important insects.

However, the total effort in study and research compared to other parts of the country was very small. During the early part of the century research was centered around Falls Church, Virginia; then at Asheville, North Carolina. About 1930 permanent personnel were assigned at Asheville; in 1935 a laboratory was opened at New Orleans, Louisiana. But until the late forties these laboratories were intermittently manned by one or two scientists, and much of their time was spent on insects affecting forest products.

Genuine interest in forest insects started about 1945 when a series of epidemics began to appear. Damage by sawflies, bark beetles, and miscellaneous defoliators aroused intense interest. It is doubtful that this interest would have come about but for significant changes in the field of forestry. Stands were being placed under intensive management, competition in the field was becoming strong, and values of the forest were climbing. Progress in the practice of intensive forestry since 1945 has been almost unbelievable. One might use the employment factor to illustrate progress: in 1945 one well-known paper company employed less than 5 professional foresters; now it employs over 50. In 1945 there were 10 consulting foresters in the whole South. Now there are about 225.

How did forest entomologists meet this new and great demand for information, for assistance and advice? Primarily, it was necessary to take information developed in other parts of the country and modify it for use in southern forests. An alternative approach was short-term, or what we commonly call "quickie" research. This tool has been a very valuable one. In general it has centered around direct control of insects through the use of insecticides. The development of synthetic organic insecticides had a profound influence upon research in forest entomology in the South as elsewhere. With the introduction of DDT in 1942 came a decade of concentrated research on insecticides and direct control, much of it "quickie" in nature. The contributions during this period were invaluable. But it was inevitable that new problems would be created; and that fundamental forest insect research programs, especially in the South with its very small number of professional forest entomologists, must suffer.

Thus, our knowledge of the life history and behavior of forest insects is limited; so is our knowledge of the relationship between the insect, its host and environment. Research funds, however, have begun to increase and our research staffs show slight increases.

Surveys

Passage of the Forest Pest Act in 1947, which made possible survey and control activities, has added immeasurably to progress in Forest Entomology. Its effect was vastly greater in the South than in any other part of the country, for until passage of the Act, there was no existing forest insect survey program as there was in the North and West. There had never been a cooperative large-scale control program. In the last six years, detection programs have been organized involving state, federal, and private industry cooperation; each year at least 4,000 foresters have attended training sessions to become acquainted with identification of insects, their detection, and control; forest pest committees

have been set up in a number of the states; state forest pest laws have been passed and states and industries have been encouraged to employ forest entomologists. (Within the past few years two paper companies and four State Forest Services in the Southeast have employed entomologists; others are considering such action.) An indirect effect of these activities, but a very valuable one, has been to stimulate in the average forester an interest in and appreciation of entomological research and research needs. Until research develops effective means to prevent or forecast destructive insect outbreaks, the survey program, particularly detection programs, will play an important part in keeping losses to a minimum.

REVIEW OF INSECT PROBLEMS, RESEARCH AND CONTROL ACTIVITIES

Reliable loss figures to illustrate damage caused by forest insects have been extremely difficult to obtain until recently. The recently issued report of the Timber Resource Review estimated that during 1952 the total losses for all insects in the Southern States, not including Virginia and West Virginia, were about 108 million cubic feet growth loss and 403 million board feet mortality loss. Since that time our more intensive survey program has revealed that annual mortality for known bark beetle outbreaks alone approaches 400 million board feet; unknown mortality-loss probably exceeds that figure.

Data on the destruction caused by wood products insects are equally difficult to obtain. We can only say that the cost runs into many millions of dollars annually.

WOOD PRODUCTS INSECTS

Probably the greatest advances in forest entomology in the South have been in wood products insects. Monumental research on taxonomy and habits of termites of the world was conducted by Dr. T. E. Snyder while he was in the South. Equally significant contributions have been made by others in every aspect of the biology and control of subterranean termites.

Most of the research on powder-post beetles of the United States was conducted in the South. Intensive studies on the biology of Lyctus spp. were followed by research on control by means of sanitation, heat treatment, starch depletion, fumigation, and application of chlorinated hydrocarbons. The latter is giving highly effective results in terms of immediate control and long-time protection.

There are a number of other powder-post beetles which do a great deal of damage. Research on these has been limited. Hylotrupes bajulus is becoming a very important problem. Among the Anobiidae, Bostrichidae, and Curculionidae are species whose damage is more or less severe.

One of the most complete pieces of research was conducted on biology and control of ambrosia beetles. In control studies every aspect of formulation, application, and persistence of insecticides was investigated. Results showed that 1/2 percent gamma BHC in oil sprayed on logs would protect them 3 to 4 months; a .075 percent concentration applied as a water emulsion dip treatment protects lumber until it is too dry for attack. These studies provided a background of information which proved to be of value in the control of other forest insects.

In response to requests from the pulp and paper industry, studies were begun in 1945 in an effort to prevent deterioration due to bark beetles and borers of pulpwood, which in the South is normally stored for 3 to 4 months with bark intact. Treatment with BHC in oil proved very promising but it was not sufficiently effective at millyards, where insect populations are abnormally high; also, it is difficult to adapt to mill practices. Improvement of the treatment or changes in storage operations may provide a solution to the problem.

FOREST INSECTS

Bark Beetles

Pine bark beetles are generally considered the most destructive forest insects in the South. Of these, the southern pine beetle, Dendroctonus frontalis, is usually the most serious. Epidemic outbreaks have been recorded periodically since 1850. In its endemic status the beetle is very obscure and sometimes impossible to find. It attacks all ages and all species of pine within its range. When conditions are favorable for epidemic outbreaks, beetle populations build up very rapidly, and areas of timber from 1/4 acre to 200 acres may be killed in a short time.

Since 1945, there has been a gradual increase in outbreaks of the beetle until at present they are occurring in most parts of the South. Over 100 million board feet have been killed annually during the last 5 years in known outbreaks.

The engraver beetles, Ips calligraphus, Ips grandicollis, and Ips avulsus are the most common of the bark beetles. During so called "normal" periods this group of bark beetles is secondary. Beetles

can always be found attacking the occasional injured, weak or felled trees. However, in recent years it has become epidemic in its activity. In most instances woods fires, storm damage, or some other breeding condition is required to begin the population build-up; beetles then move rapidly into apparently healthy trees even before all injured trees are infested. Such abnormal situations are not always required, however; beetles may attack trees only in groups of 1 to 3 but these kills occur in much greater frequency than during "normal" periods. In 1955 an estimated 200 million board feet were killed by Ips spp.

The engraver beetles and the southern pine beetle have short life cycles and produce 4 to 6 generations per year. The latter, however, has a much greater biotic potential, produces many more beetles, and kills many more trees during a season.

Control of these beetles usually consists of rapid salvage, lopping of tops, and general sanitation. Salvage is often practicable because of many portable sawmills and the heavy demand of the large pulpwood industry. When it is impracticable to salvage, a residual penetrating spray is applied to felled trees. Many series of screening tests conducted in various parts of the South proved that 1/4 percent gamma BHC in oil is the most effective insecticide treatment.

Until 1949, the black turpentine beetle, Dendroctonus terebrans, was always regarded as secondary; no epidemic outbreaks were on record, and tree mortality was very rare. Since that year, it has been killing trees throughout the South. It was first observed following cutting operations; then, in 1951 it was found killing trees following the southern pine beetle outbreak in Texas, and in the same year it caused pine mortality in the naval stores region of Florida. Damage during 1955 was estimated at 50 million board feet; there was probably an equal or greater loss to the naval stores industry due to loss of gum trees and reduction in size of the naval stores crop through fear of the beetle's activities.

The beetle infests all species of pine in the South, confining its attack to the base of the trees. Subsequent attack on roots destroy their function and contribute to the tree's death. The beetle has a life cycle of 3 to 4 months.

Studies on direct control involving many chemicals and formulations have resulted in the development of treatments to prevent breeding in stumps and to protect high value specimens such as naval stores trees and seed trees and those used in tree improvement programs such as genetically superior individuals. A 1 percent gamma concentration of BHC in fuel oil, applied as a coarse spray, was found to be the most effective treatment.

Defoliators

In the South, there are at present no defoliators as destructive as the spruce budworm, the Douglas-fir tussock moth, and the larch sawfly. We have a great many species but so far as we know their injury seldom causes direct mortality. In recent years, however, there has been increasing concern about the possible effect of defoliation on tree growth or susceptibility to attack by other insects. Probably the first occasion of concern was in 1947 when the loblolly pine sawfly, Neodiprion taedae linearis, defoliated loblolly pine of all ages in over 1-1/2 million acres of forest land in southern Arkansas. Observations over several years revealed no appreciable mortality resulting from this defoliation, but studies showed a severe growth loss of 20 million board feet during the peak year. The insect has since been found in northern Louisiana and Texas.

There are, in the South, at least seven other species of sawflies about which little or nothing is known. Some of these might potentially be more serious than the species discussed above because they defoliate in late summer and fall when re-foliation is poor and trees are predisposed to lethal attack by bark beetles.

Space does not permit discussion of the many other defoliators considered to be serious in their effect on trees. They include such species as the cypress looper, the cypress leaf beetle, the snow white linden moth, the fall cankerworm, the forest tent caterpillar and the oak leaf miner. Periodically, areas of a few hundred to many thousand acres are defoliated. The effect of their damage has never been fully studied but in some instances obvious effects have been noted such as stand deterioration and, in the presence of adverse growing conditions, mortality.

Pales and Other Reproduction Weevils

Until a few years ago the Pales weevil, Hylobius pales, was considered an insect problem of the Northeast only, where it girdled and killed young white and red pine around logging areas and similar points of attraction. There are no published records of injury to southern pine previous to 1940. That year it was reported causing serious damage to pine in recently cut-over areas on the Duke University Forest. In 1948 near Hodge, Louisiana, the weevil virtually wiped out a pine plantation established in an area which had been burned and salvaged. At this time, another weevil, Pachylobius picivorus, was collected. Since then, reports of damage by these insects have been increasingly common as planting programs have been enlarged. The recent development in management practices to cut and plant pine has also increased losses by the weevils.

The method of control in the Northeast in past years was to delay planting for three years, until the beetle completed its activities and left the area. This method has been largely rejected in the South because of heavy growth of hardwood reproduction on many sites during this waiting period. Thus far, insecticides have offered the best promise of quickly developing a method of control; indirect methods might be most effective in the long run, but their development will require considerable time.

A very promising form of control has been developed which consists of dipping seedlings in a 2 percent water emulsion of aldrin. At a cost of about 15 cents per thousand, over 80 percent of the seedlings can be protected during the period when beetles feed. Preliminary tests of spray solutions and dry granular insecticides, for use under special conditions, likewise show promise.

Pine Moths

The pine moth, Rhyacionia frustrana, is familiar to foresters in the South. Damage by this insect, which consists of mining out buds and shoots, usually causes 6 to 8 inches growth loss per year for 6 to 10 years. On poor growing sites the damage may cause dwarfing. Injury to loblolly and shortleaf pines has been so serious in some areas that these pines are being replaced by other species.

Reasonably effective control measures have been developed in recent years but have not been accepted because cost of control usually exceeds the losses. Two applications of a 1 percent water suspension or emulsion of DDT to infested trees, accurately timed to kill the larvae of the first two spring generations, has given a high degree of control. Spraying by aircraft was studied briefly against another species of tip moth some years ago but proved unsatisfactory. It should be more thoroughly investigated in the South. Application of concentrated sprays with mist blowers also needs study as a possible inexpensive method of control.

CONTROL OF INSECTS BY INDIRECT MEASURES

In the above review of various destructive insects, only direct control measures have been discussed as each pertains to the particular species concerned. This discussion of indirect control applies broadly to all species.

Generally speaking, before we can develop sound methods of indirect control in the South, we must have more information on the relationship of the various insects to their environment. For example, in any discussion of the epidemiology of bark beetles,

drought is always listed as the major factor. Yet abundant rainfall does not always end epidemics. On the other hand, epidemics have ceased completely while drought continued. In the case of the southern pine beetle there are many drought areas, having a past history of severe epidemics, that are presently unaffected by the beetles. It appears likely that a combination of factors or conditions--biology of the beetle and its natural enemies, climate, forest stand density and volume, and the soil--are involved. Discovery of the nature of this combination may someday lead to development of effective methods of biological or silvicultural control.

There are instances when the possibilities of control by simple management practices appear so obvious that basic information seems unnecessary; for example, control of black turpentine beetle by temporary cessation of naval stores; or control of Ips by stopping summer cutting. But these methods do not conform to the economy of our forest industry; they are expensive--and in effect, they constitute an attempt to escape the problem rather than solve it. Basic information will lead to more effective control through management and biological and silvicultural methods.

The need for fundamental study applies equally to defoliators. The possibilities that lie in biological control through the use of natural enemies are well known to all of us. Less well known, however, is the effect of climate on the condition of the host; for example, as it relates to injury caused by defoliation. The numerous epidemic outbreaks of different species of defoliators during recent years suggest an environmental influence; study of the relationship of the insect to its environment may reveal strong climatic or site influences which could lead to development of silvicultural control techniques.

In the control of the Pales weevil there seem to be several possibilities of control by management--proper timing of the harvest cut to reduce beetle breeding, and cutting during high seed years to insure an adequate seedling crop despite weevil damage. These possibilities, however, can be satisfactorily tested only when fundamental information is available.

Although there will always be a place for the application of insecticides and similar direct control measures, long-time protection will come only through natural methods of control which will require painstaking basic research.

FUTURE PROBLEMS IN FOREST ENTOMOLOGY

The above review of forest entomology in the South has been presented by describing some of the better known problems. However,

there are many problems which are only being explored at present. Also, if we look into the not-too-distant future we can see new problems developing.

In the former category are the insects which affect hardwoods. As previously indicated, the South's forest economy has largely revolved about pine. There is now a gentle swing toward hardwoods and it is the writer's opinion that this move will gain momentum very rapidly in the next decade. Interest in insect damage is clearly evident. Recent exploratory studies in Kentucky reveal that 75 percent of oak lumber is severely damaged by borers. Management studies recently established in Georgia show heavy borer damage even in young saplings. The task of determining the insects causing the injury, their life histories and the conditions favoring their activity will be a formidable one; devising control measures will be equally challenging.

Interest in the field of forest genetics in the South has mounted rapidly in the past five years. Forest entomology must progressively play an important and essential part in many of the developments. Already insect problems have arisen. Scions of slash pine grafts are highly susceptible to attack by a bark beetle, Pityophthorus pulicarius, and it has become necessary to develop control measures. In making pollen crosses, certain cone insects cause a high mortality of seed; studies have begun to determine ways of controlling this loss. In seed orchards, pine tip moths are expected to lower cone production, as they destroy the flower buds of the low-growing trees. Current examinations of seed source studies suggest that susceptibility or resistance to insect attack may be related to seed source. There is evidence that certain trees exhibit resistance to insect attack, as in the case of bark beetles. The idea of inbreeding trees with resistance is not a particularly hopeful one to many entomologists but its possibilities must not be overlooked.

Looking into the future, as the forest industry of the South continues its enormous strides, one can see possibilities of many new problems developing unless they are anticipated and preventive measures taken. The tremendous southern planting program (475 million seedlings planted in 1956, and 1 billion predicted for 1970) will bring insect problems in the numerous new nurseries needed to produce planting stock. Later will come different problems associated with plantations; still later the problems of the young and the maturing stand. In considering the future, one might contemplate with alarm the vast plantings of pure even-aged stands of pine and the danger that exists from attack by some of the primary insects discussed before. That is, unless we have confidence in our ability to develop, in the near future, the biological, silvicultural or management methods of preventing insect outbreaks. In our attempts to develop and establish such methods of control we must have full cooperation

of forest managers. For the southern forest with its rapid growth and short rotation encourages frequent change in management systems. Such changes could jeopardize silvicultural control measures. Foresters must realize too that the environmental changes that go with intensive management--road building, draining, prescribed burning, clear cutting, etc., may have adverse effects on the stand with respect to susceptibility to insect attack.

Though the future presents many problems, there are signs that these will be met successfully. Entomology is being recognized as an integral part of forest protection. Insect detection programs are taking effect and every year sees more foresters in the woods to aid in the program. Aerial survey techniques in the South are being improved through research. And, perhaps most important is the fact that foresters are recognizing the value of all these efforts--the fundamental as well as the "quickie" research, and the survey as well as the service activities of the entomologist.